(12)

ONR ANNUAL PROGRESS REPORT 1992

Peter Muller
University of Hawaii
1000 Pope Road, MSB 307
Honolulu, HI 96822

(808) 956-8081

SCIENCEnet Mailbox: P.MULLER/OMNET

Internal Gravity Waves at Abrupt Topography ONR N00014-89-J1315

Research Goals:

Identification and modeling of the dynamical processes that determine the oceanic internal gravity wave spectrum, its evolution, and its variability. Understanding the role that internal gravity waves play in the redistribution and mixing of momentum, potential vorticity, heat, and salt.

Objectives:

Description and modeling of the interaction between internal gravity waves and irregular bottom topography. Determination of the significance of this interaction. Identification of appropriate theoretical tools to describe the interaction in oceanographically relevant parameter ranges.

Approach:
Analytic and numerical modeling.

Tasks Completed:

Comparison of the efficiency of reflection at a critical slope and scattering at random bottom topography in causing a transfer of energy to high wavenumbers and boundary mixing. Derivation of filtered equations to study and numerically simulate the interaction of near-inertial internal gravity waves with bottom topography. Initial numerical experiments to investigate whether or not internal waves interacting with bottom topography exhibit chaotic behavior.

Scientific Results:

The interaction of internal gravity waves with irregular or random bottom topography is a highly nonlinear process whose effects on the internal wave field are not fully understood

yet. Both the reflection of internal waves at critical slopes (Eriksen, 1985) and the scattering at benign random topography (Muller and Xu, 1992) lead to a transfer of wave energy to high wavenumbers and therefore enhance wave breaking and mixing near topography. Both the reflection and the scattering theory require that the horizontal wave number of the internal wave field be larger than the horizontal wavenumber of the bottom topography. This condition becomes invalid for the energetic near-inertial internal gravity waves whose horizontal wavenumber is small. Other approaches are required in this case. Direct numerical modeling with filtered equation and application of geometric thermodynamics look promising.

Eriksen, C.C., 1985: Implications of ocean bottom reflection for internal wave spectra and mixing. J. Phys. Oceanogr., 15, 1145-1156.

Muller, P. and N. Xu, 1992: Scattering of oceanic gravity waves off random bottom topography. J. Phys. Oceanogr., 22, 474-488.

Accomplishments:
Theoretical comparison of the efficiency of reflection and scattering in causing transfer of energy to high wavenumbers. Results show that scattering might be as efficient as reflections in causing high shears and boundary mixing.

ONR-Sponsored Publications

P- Muller, P., and N. Xu, 1992: Scattering of oceanic gravity waves off random bottom topography. J. Phys. Oceanogr. 22, 474-488.

R- Xu, N., and P. Muller, 1991: Is scattering or reflection more effective in causing boundary mixing?, In: "Dynamics of Oceanic Internal Gravity Waves.: Proceedings, 'Aha Huliko'a Hawaiian Winter Workshop, School of Ocean and Earth Science and Technology, Special Publication." 237-250.

Statistics
1 Papers published, refereed journals
0 Papers submitted, refereed journals
0 Books or chapters published, refereed publication
0 Books or chapters submitted, refereed publication
0 Invited presentations
0 Contributed presentations
1 Technical reports and papers, non-refereed journals

0 Undergraduate students supported
2 Graduate students supported
0 Post-docs supported
1 Other professional personnel supported

EEO/Minority Support
0 Female grad students
0 Minority grad students
0 Asian grad students
0 Female post-docs
0 Minority post-docs
0 Asian post-docs

Patents and awards

Influences:

Brown, M.G., Tappert, F.D., and S.E.R.B. Sundaram, 1991:
Chaos in small-amplitude surface gravity waves over slowly
varying bathymetry. J. Fluid Mech., 227, 35-46.

Mann, J.A., Rains, E.M., and W.A. Woyczynski, 1991:
Measuring the Roughness of Interfaces. Center for Stochastic
and Chaotic Processes in Science and Technology. Preprint #91-111.

Gilbert, D. and C. Garrett, 1989/ Implications for ocean
mixing of internal wave scattering off irregular topography.
J. Phys. Oceanogr., 19, 1716-1729.